

Electron Beam Lithography for the Fabrication of Air-bridged, Submicron Schottky Collectors

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0.1 micron T-shaped Schottky diode collectors have been specially fabricated to incorporate an extremely small footprint as well as an air-bridge structure.

Schottky-collector resonant tunneling diodes (S-CRTDs) were recently demonstrated on GaAs substrates [1]. Low frequency measurements and calculations indicate that they will have a cutoff frequency higher than conventional RTDs. The higher cutoff frequency estimated for our S-CRTDs are the result of a much lower parasitic resistance than in conventional RTDs; this lower resistance is partly due to the basic device concept and partly due to the use of a very small collector.

The collectors were fabricated using a HI/LO/HI T-gate technique often used in the processing of HEMT gates. This process minimized the size of the collectors while avoiding high metal resistance. However, the collectors were designed to allow for a subsequent mesa etch that completely undercuts the center of the collector finger, leaving it supported only by the active diode region and the contact area. This air-bridge structure is necessitated by the thick, highly doped semiconductor layers which prevent the possibility of running the collector finger over the edge of the mesa. Also because of the thick semiconductor device structure, the various methods previously demonstrated for undercutting metal structures would not work; in particular, wet etching the mesa after conventional collector definition [2] results in an excessively fast etch rate at the metal-semiconductor interface, usually resulting in a completely disconnected collector.

In order to avoid the latter problem while still using a wet mesa etch, we incorporated a bridging technique first demonstrated for larger area structures [3]. Careful specification of e-beam exposure doses made it possible for the footprint of the collector to penetrate the bottom layer of the resist only in selected areas. In this case the opening was made over what would later become the active mesa, thus the diode area is controlled independently of the wet etched mesa area, and the localized electrochemical etching problem is avoided.

Using these techniques, devices with single diode footprints as small as 0.1×0.5 microns and multiple footprints of 0.1×0.3 microns have been successfully fabricated on InGaAs and GaAs [1], respectively,

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- [1] S.T. Allen, et al, *IEDM*, 1993, and submitted to *Electron Device Letters*.
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- [3] A. Ketterson, et al, *J. of Vac. Sci. Tech. B*, 10, p. 2936 (1992)

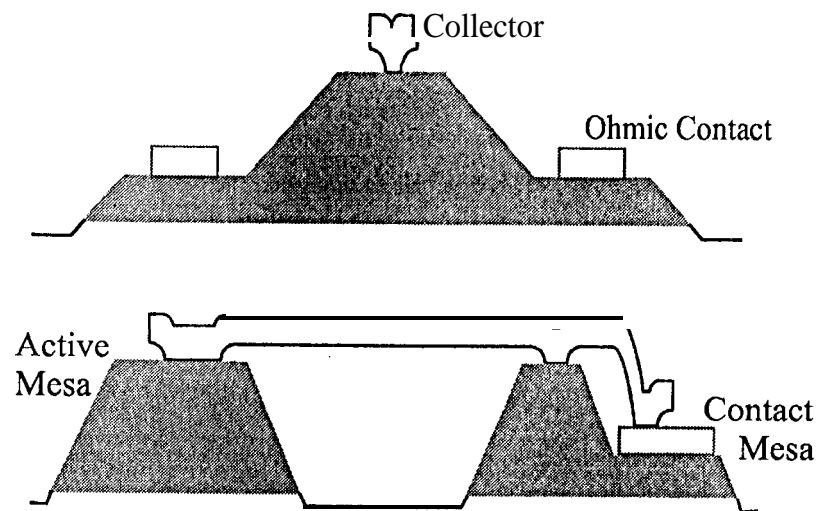
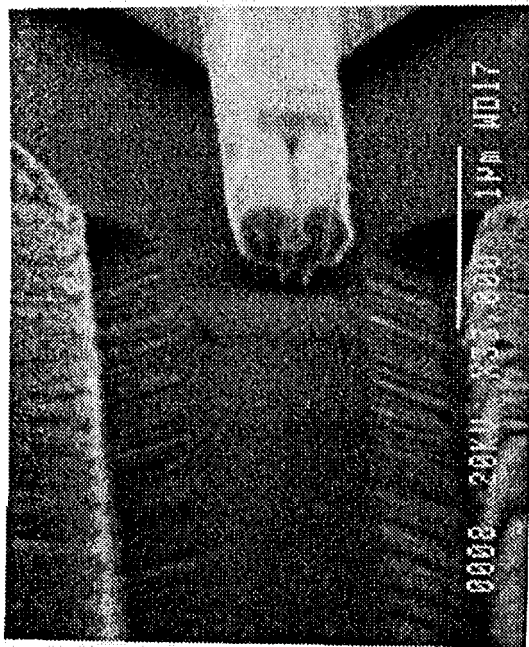
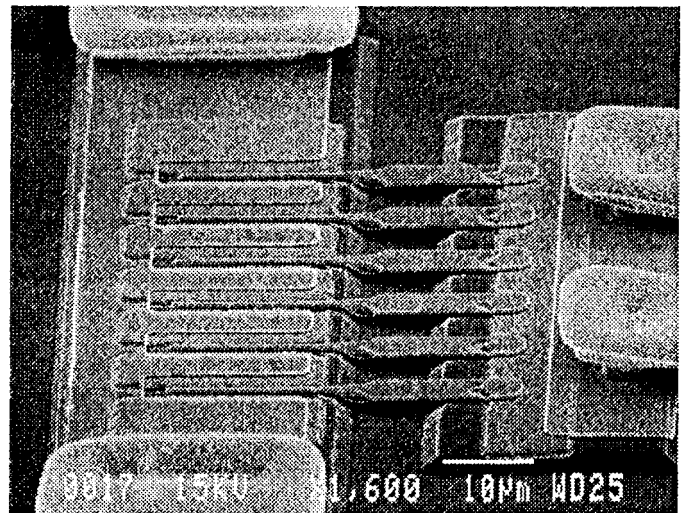


Figure 1. End view and cross-sectional side view of air-bridged Schottky collectors,



(a)



(b)

Figure 2. (a) End view of 0.1 micron Schottky collector. (b) Completed 0.1 μm by 17 μm by six finger Schottky collector resonant tunneling diode.